

Campbell 2. f. 1.
61-2472

*John F. Campbell Esq
With kind regards
from John Evans
7.*

British Association for the Advancement of Science.

DUBLIN,

1878.

acknowledged

Sept 18. 1878

*J. F. Campbell
Middley Lodge
Kensington*

AN ADDRESS

DELIVERED IN THE DEPARTMENT OF GEOLOGY,

August 15, 1878.

BY

JOHN EVANS, D.C.L., F.R.S., F.G.S., &c.

LONDON:

PRINTED BY VIRTUE & CO., LIMITED, CITY ROAD.

AN ADDRESS.

IN opening the proceedings of this section, I cannot but call attention to the fact that the present is the third occasion on which the British Association has met in this city, its first meeting here having taken place in the year 1835, or forty-three years ago. On that occasion, as indeed for many years afterwards, the two distinct, though to some extent cognate branches of study, Geology and Geography, were classed in the same Section, and its president was a man of whom Irish science may well be proud, and who, I am thankful to say, is still living to enjoy his well-deserved honours—the veteran geologist, Sir Richard John Griffith, the author of the first Geological Map of Ireland. It seems hardly credible that the construction of this map was commenced in the summer of 1812, or sixty-six years ago; but the records of the Geological Society of London testify to the still more remarkable fact that Sir Richard Griffith was elected a fellow of that society in 1808,—seventy years ago. Indeed, in 1854, when the Wollaston medal was awarded to the then Dr. Griffith, the president, the late Professor Edward Forbes, spoke as he said reverentially to one of the earliest members of the society, and to a geologist who appeared in print before he, the president, was born. It was well said

on that occasion that the map lately mentioned was one of the most remarkable geological maps ever produced by a single geologist; and I make no doubt that those who are at present engaged on the Geological Survey of this island will testify, as did their predecessors, to the value of this “surprising monument of observation and skill.”

When speaking of the Geological Survey of Ireland, it will not, I am sure, be thought out of place if I offer here a tribute of respect to the memory of one who was originally a student in the College within whose walls we are assembled, and who subsequently occupied posts of the highest importance in connection with the Geological Society of Dublin and the Geological Survey of Ireland, besides filling the professorial Chair of Geology in this University: I mean Dr. Thomas Oldham, the late Director of the Geological Survey of India. With the marvellous amount of work which he was enabled to accomplish in that country you are all acquainted, and you will all share in the regret that the period of his well-earned retirement—that “*requies optimorum meritorum*”—should have been so quickly cut short by death. His name will, however, long survive, and future students of geology will have no difficulty in recognising the distinguished labourer in their science after whom the Cambrian *Oldhamia* of the Wicklow hills so worthily received its name.

But to return to this Association.

On the next occasion of its meeting in Dublin, in 1857, Section C. had become devoted to Geology alone, and Geography was excluded, the president being Lord Talbot de Malahide, a nobleman whom also we still have among us, and who is alike well known to archaeologists and geologists.

As the last meeting of the Association in this city took

place twenty-one years ago, it would at first sight appear that in opening our proceedings I might with propriety dwell on the progress which has been made within that period in the development of the geology of Ireland. I must, however, remind you that it is only four years since the Association held its meeting in what I may almost call the neighbouring town of Belfast, when the accomplished chief of the Geological Survey in Ireland presided over this section and delivered an address, in which some of the more interesting features of the country, especially those of the volcanic district of the north-east of this island, were discussed. During the present year, moreover, he has published his comprehensive work on the Physical Geology and Geography of Ireland, which I commend to you as far more likely to call your attention to the characteristic features of the country and the latest discoveries with regard to its geology than anything I could compile.

In addition to this, there has appeared during the present year another interesting volume, which records the impressions of a highly intelligent foreign geologist on visiting this country. I mean the "Aus Irland" of Dr. Arnold von Lasaulx, Professor of Mineralogy in the University of Breslau. For this volume, in which shrewd remarks on the country and its inhabitants are mingled with geological observations and valuable comparisons of the Irish formations with those of other countries, we are indebted to the meeting of the British Association having been held two years ago at Glasgow, which attracted the author to visit the British Islands.

So much having lately been published upon the geology of this country, I shall content myself with making a very few general observations with regard to it, and propose subsequently to touch briefly on some of those questions

which, within the last twelve months, have occupied the attention of those who are engaged in the advancement of our science.

As to the geology of this country, I may observe that we are here assembled just on the edge of that great central plain which forms so important a feature in the map of Ireland, and which stretches from Dublin Bay on the east coast to Galway Bay on the west, with hardly a portion of it attaining to an elevation of three hundred feet above the sea, over a tract of country nearly one hundred and fifty miles in extent in almost every direction.

The boundaries of this great plain and those of the Carboniferous Limestone almost coincide, so that we have here the somewhat remarkable feature of a formation which in England is of such a character as to have received the name of the Mountain Limestone, constituting in the neighbouring island nearly the whole of the plain country. In some of the north-western counties, however, as for instance Fermanagh and Sligo, it assumes its more mountainous character. Nearly the whole of this central plain is overlain with boulder clay, limestone gravel or middle drift, and extensive bogs, so that the subjacent rock is but occasionally seen. In several places detached bosses of Old Red Sandstone rise through the limestone, and there is also good reason for believing, with Professor Hull, that the whole of the area was at one time covered with the upper members of the carboniferous group, including the true coal measures, of which unfortunately but small patches remain, and those upon the margin of the plain. From the absence of the upper Palæozoic, Mesozoic, and Cainozoic formations over the area, Professor Hull has arrived at the conclusion that the surface remained in the condition of dry

land, while that of England was being submerged beneath the waters of the sea, over the bed of which nearly all these formations were deposited. To a certain extent, however, he leaves it an open question whether some of the Mesozoic strata which occur over the north-east of Ireland may not have been deposited over the centre and south. The amount of denudation over this central area has, no doubt, been such that the chances of even Professor Judd finding traces of these later deposits appear at first sight to be but small; but whether the whole of this vast amount of denudation is due to the wasting influence of rain, rivers and other sub-aërial agents of erosion, is a question which I venture to regard as at all events open to discussion. It appears to be the case that in some parts of the north of Ireland the whole of the upper carboniferous beds had been denuded before the deposition of any Permian strata, as these are deposited immediately on the Carboniferous Limestone; and if this amount of denudation had taken place in pre-Permian times in the north, there seems a possibility of the same having been the case in central Ireland. If so, it is possible that some traces of the later deposits may yet be found on the central plain. Certainly, if we are still to regard the white chalk as a deep-sea deposit, the cretaceous rocks of the north-east of Ireland must have at one time extended farther south than they do at present, and somewhere or other there must have been shore deposits of that period formed further south than the Upper Greensand of Antrim. The careful investigations of Professor Judd have largely extended our knowledge of the Secondary rocks of the western coast and islands of Scotland, and he has been able to show that the Jurassic series of the Western Highlands could not have had a thickness of less

than three thousand feet. It is therefore hard to believe that with such a development in so closely neighbouring a district, the deposits of the same age in Ireland can have been restricted to their present area.

Professor Judd considers that the amount of denudation in the Scottish Highlands since the Mesozoic and even the Miocene period, has been enormous, and that the great surface features of the Highlands were produced in Pliocene times. It seems therefore possible, if not probable, that so long a period of exposure to sub-aërial influence as that assigned to the central plain of Ireland by Professor Hull, would have resulted in a more uneven land surface than that which we now find. At all events, the history of this remarkable physical feature is one which is of high interest, and can hardly as yet be considered as closed.

With regard to the mountainous districts surrounding the central plain, we shall, I believe, have the opportunity of visiting some parts of the Wicklow Mountains, a district from which a portion, at all events, of the native gold of Ireland was procured in ancient times, as indeed it continues to be. Of the abundance of gold in this country in early times, a glance at the magnificent collection of ancient ornaments preserved in the museum of the Royal Irish Academy will serve to give an idea. Even in times more recent than those in which the bulk of these ornaments were made, gold was an important product of this country, and I am tempted to quote a few lines from an early English poem, "The Libell of Englishe Polieye," written in the year 1436. In treating of the commodities of Ireland, the author says that the country is

" So large, so gode, and so commodious
That to declare is straunge and mervelous.

For of silver and gold there is the ore
 Among the wilde Irish, though they be pore ;
 For they ar rude and can theron no skille
 So that, if we hadde ther pese and good wille,
 To mine and fine and metal for to pure
 In wilde Irishe mighte we find the cure ;
 As in Londone saith a jewellere
 Which broughte from thennes gold oor to us here,
 Wherof was fined metal gode and clene,
 That at the touch no better conde be sene."

Sir William Wilde has observed that the south-western half of Ireland has yielded a greater amount of gold antiquities than the north-western, and probably this would hold good with regard to the production of the metal itself, though it has been found in the counties of Antrim, Tyrone, and Derry, as well as in those of Dublin, Wicklow, Wexford, and Kildare.

The north-east of Ireland possesses, however, another geological feature peculiar to itself in that great expanse of volcanic beds which formed the subject of Professor Hull's address to this section at the Belfast meeting. My only object in now mentioning them is again to call attention to their containing the only remains of a Miocene flora which are to be found in this island. Analogous beds were detected in the corresponding basalts in the Island of Mull by the Duke of Argyll in 1851. With the exception of the Hempstead beds of the Isle of Wight, which should probably be classed as Oligocene, and the Bovey Tracey beds of Devonshire, these are almost the only deposits of Miocene age in the British Isles. The contrast presented by the scarcity of deposits of this period in Britain with their abundance in the north-west, centre, and south of France, Switzerland, and generally in the south of Europe, is striking. Instead of thick deposits covering hundreds of square miles of country,

like the Miocene beds bordering the Pyrenees or those of the great system of the Auvergne, we have small patches owing their preservation either to volcanic outbursts having covered them up, or to some favourable circumstance having preserved them from total denudation. Whether we are to assume with the late Professor Edward Forbes, that the general dearth of these strata in the British Isles arose from the extent of dry land which prevailed during the long interval between the Eocene and Pliocene periods, or whether we assume the former existence of widespread marine deposits which have since been entirely removed, the case is one not without difficulty. At all events, the absence of representatives of this period within the British area has a tendency to prevent a due appreciation of the enormous extent of the Miocene period being generally felt in this country. Nor, generally speaking, do we, I think, take a fair estimate of the remoteness in time to which we must date back the commencement of that lengthened period. Professor Haughton, judging from the maximum observed thickness of each successive deposit, has calculated that a greater interval of time now separates us from the Miocene period than that which was occupied in producing all the Secondary and Tertiary strata from the Triassic to the Miocene epoch, and, without endorsing the whole of my accomplished friend's conclusions, I incline to concur in such an estimate. When it is considered that the Ballypally beds of Antrim and the Lough Neagh clays are the sole representatives in Ireland of two periods of such length and importance as the Miocene and Pliocene, their high interest will be more apparent, and I trust that no opportunity of minutely studying them will be neglected.

There is one other point with regard to Irish geology

on which it will be well to say a few words, though it is of a negative rather than a positive character. I mean the absence, so far as at present known, of Palæolithic implements in this country. It is true that Professor Hull, in the book to which I am so much indebted, speaks of a raised beach on the Antrim coast as containing worked flints of that rude form and finish known as Palæolithic; but this is a slip of the pen, by which the author has fallen into the not uncommon error of applying a term which is merely significant of the age of the implements to their external character. However rude may be the workmanship of the flint implements found at Kilroot, they belong to the Neolithic, and not to the Palæolithic period. So far as I am aware no example of any implement belonging to the age of the mammoth, rhinoceros and other members of the quaternary fauna has as yet been found in Ireland. Indeed, the remains of *Elephas primigenius* and its associates are of exceedingly rare occurrence in this country, though they have been found with those of bear and reindeer in the Shandon Cave near Dungarvan. It is, of course, impossible to foretell what future researches may bring to light; but judging from analogy it seems hardly probable that until ancient river-gravels containing the remains of the quaternary group of mammals are found in this island, veritable Palæolithic instruments will be discovered. The association of the two classes of remains is so constant that we may fairly assume that the animals formed the principal food of the Palæolithic hunters, and that any causes which lead to the absence of the one class will lead to the absence of the other also.

There is, however, one member of that old quaternary group which is far more abundant in Ireland than it is in

England or on the continent of Europe—the *megaceros*—which has rightly received the appellation of *Hibernicus*.

I hope that we may have an opportunity, under the guidance of Mr. Richard Moss, of seeing some of the remains of this “antlered monarch of the waste” in the position in which they were originally interred, and it will be an interesting question for consideration whether these remains can be regarded as of the same geological age as those of the English caves and river-gravels, or whether they do not for the most part belong to what Professor Boyd Dawkins has termed the Pre-historic period. It seems by no means improbable that this gigantic stag survived in this country for ages after he had become extinct in other lands, and that the view held by Professor Hull of his extinction being due to persecution by man is correct. If this be so it would seem to follow that the human occupation of Ireland is of far more recent date than that of the sister country.

And this brings me to one of those questions which have of late been occupying the attention of geologists. I mean the date which is to be assigned to the implement-bearing beds of Palæolithic age in England. Dr. James Geikie has held that for the most part they belong to an interglacial episode towards the close of the Glacial period, and regards it as certain that no Palæolithic bed can be shown to belong to a more recent date than the mild era that preceded the last great submergence.

His follower, Mr. Skertchly, records the finding of Palæolithic implements in no less than three interglacial beds, each underlying boulder clays of different ages and somewhat different characters, the Hessle, the purple, and the chalky boulder clay. This raises two main questions, first, as to how far Dr. Croll’s theory of the great alterna-

tions of climate during the Glacial period can be safely maintained; and secondly, how far the observations as to the discovery of implements in the so-called Brandon beds underlying the chalky boulder clay can be substantiated. Another question is how far the Palæolithic deposits can be divided into those of modern and ancient valleys, separated from each other by the purple boulder clay, and the later of the two older than the Hessle beds. It would be out of place here to discuss these questions at length. I will only observe, that in a considerable number of cases the gravels containing the implements can be distinctly shown to be of much later date than the chalky boulder clay, and that if the implements occur in successive beds in the same district, each separated from the other by an enormous lapse of time, during which the whole country was buried beneath incredibly large masses of invading ice, and the whole mammalian fauna was driven away, it is a very remarkable circumstance. It is not the less remarkable because this succession of different Palæolithic ages seems to be observable in one small district only, and there is as close a resemblance between the instruments of the presumedly different ages as there is between those of admittedly the same date. I have always maintained the probability of evidence being found of the existence of Man at an earlier period than that of the post-glacial or quaternary river gravels, but, as in all other cases, it appears to me desirable that the evidence brought forward should be thoroughly sifted and all probability of misapprehension removed before it is finally accepted. In the present state of our knowledge, I do not feel confident that the evidence as to these three successive Palæolithic deposits has arrived at this satisfactory stage. At the same time it must be borne in mind that if we make the

Palæolithic period to embrace not only the river gravels but the cave deposits of which the south of France furnishes such typical examples, its duration must have been of vast extent.

In connection with the question of Glacial and Inter-glacial periods, I may mention that of climatal changes in general, which has formed another subject to which much attention has of late been given. The return of the Arctic Expedition, and the reports of the geological observations made during its progress, which have been published by Captain Fielden, one of the naturalists to the expedition, in conjunction with Mr. De Rance and Professor Heer, have conferred additional interest on the question of possible changes in the position of the poles of the earth, and on other kindred speculations. Near Discovery Harbour, about latitude $81^{\circ} 40'$, Miocene beds were found containing a flora somewhat differing from that which was already known to exist within the Arctic regions. "The Grinnell Land lignite," say the authors of the report, "indicates a thick peat moss, with probably a small lake, with water lilies on the surface of the water, and reeds on the edges, with birches, poplars, and taxodiums on the banks, and with pines, firs, spruce, elms, and hazel-bushes on the neighbouring hills." When we consider that all of the genera here represented have their present limits at least from twelve to fifteen degrees farther south, while the taxodium is now confined to Mexico and the south of the United States, such a sylvan landscape as that described seems entirely out of place in a district within six hundred miles of the pole, to which indeed, if land then extended so far, these Arctic forests must have also extended in Miocene times. Making all allowance for the possibility of the habits of such plants

being so changed that they could subsist without sunlight during six months of a winter of even longer duration, I cannot see how so high a temperature as that which appears necessary, especially for the evergreen varieties, could have been maintained, assuming that Grinnell Land was then as close to the North Pole as it is at the present day. Nor is this difficulty decreased when we look back to formations earlier than the Miocene, for the flora of the secondary and Palæozoic rocks of the Arctic regions is identical in character with that of the same rocks when occurring twenty or thirty degrees farther south, while the corals, encrinites, and cephalopods of the carboniferous limestone are such as, from all analogy, might be supposed to indicate a warm climate.

The general opinion of physicists as to the possibility of a change in the position of the earth's axis has recently undergone modifications somewhat analogous in character to those which, in the opinion of some geologists, the position of the axis has itself undergone. Instead of a fixed dogma as to the impossibility of change, we find a divergence of mathematical opinion and variations of the pole differing in extent, allowed by different mathematicians who have of late gone into the question, as for instance the Rev. J. F. Twisden,¹ Mr. George Darwin,² Professor Haughton,³ the Rev. E. Hill,⁴ and Sir William Thomson.⁵ All agree in the theoretical possibility of a change in the geographical position of the earth's axis of rotation being affected by a redistribution of matter on

¹ Quart. Jour. Geol. Soc., 1878, p. 35.

² Proc. R. S., vol. xxv. p. 328. Phil. Trans., clxvii. p. 271.

³ Proc. R. S., 1877, 1878.

⁴ "Geol. Mag.," June, 1878.

⁵ Rep. Brit. Assoc., 1876, p. 11.

the surface, but they do not appear to be all in accord as to the extent of such changes. Mr. Twisden, for instance, arrives at the conclusion that the elevation of a belt twenty degrees in width, such as that which I suggested in my presidential address to the Geological Society in 1876, would displace the axis by about ten miles only, while Professor Haughton maintains that the elevation of two such continents as Europe and Asia would displace it by about sixty-nine miles, and Sir W. Thomson has not only admitted, but asserted as highly probable, that the poles may have been in ancient times "very far from their present geographical position, and may have gradually shifted through ten, twenty, thirty, forty, or more degrees without at any time any perceptible sudden disturbance of either land or water."

I am glad to think that this question, to which I to some extent assisted to direct attention, has been so fully discussed, but I can hardly regard its discussion as being now finally closed. It appears to me doubtful whether eventually it will be found possible to concede to this globe that amount of solidity and rigidity which at present it is held to possess, and which to my mind at all events seems to be in entire disaccordance with many geological phenomena. Yet this, as the Rev. O. Fisher⁶ has remarked, is presupposed in all the numerical calculations which have been made. I am also doubtful whether in the calculations which have been made, sufficient regard has been shown to the fact that a great part of the exterior of our spheroidal globe consists of fluid which, though of course connected with the more solid part of the globe by gravity, is readily capable of readjusting itself upon its sur-

⁶ "Geol. Mag.," July, 1878.

face, and may, to a great extent, be left out of the account in considering what changes might arise from the disturbance of the equilibrium of the irregular spherical or spheroidal body which it partially covers. It appears to me also possible that some disturbances of equilibrium may take place in a mysterious manner by the redistribution of matter or otherwise in the interior of the globe. Captain F. J. Evans,⁷ arguing from the changes now going on in terrestrial magnetism, has suggested the possibility of some secular changes being due to internal, and not to external causes; and if it be really true that there is a difference between the longest and shortest equatorial radii of the earth, amounting to six thousand three hundred and seventy-eight feet,⁸ such a fact would appear to point to a great want of homogeneity in the interior of our planet, and might suggest a possible cause for some disturbance of equilibrium.

I have mentioned Professor Haughton among those who, from mathematical considerations, have arrived at the conclusion that a geographical change in the position of the axis of rotation of the earth is not only possible but probable. In a recent paper, however, he has maintained, notwithstanding this possibility or probability, we can demonstrate that the pole has not sensibly changed its position during geological periods. He arrives at this conclusion by pointing out that in the Parry Islands, Alaska and Spitzbergen, there are Triassic and Jurassic deposits of much the same tropical character, and then by a geometrical method fixing the North Pole somewhere near Pekin, and the south pole in Patagonia, within seven hundred miles of a spot where Jurassic ammonites occur,

⁷ *Nature*, May 16, 1878.

⁸ Thomson and Tait, *Phil.* p. 648.

shows that such a theory is untenable. In the same way he fixes the pole in Miocene times near Yakutsk, within eight hundred miles of certain Miocene coal beds of the Japanese islands. These objections are at first sight startling, but I think it will be found that if, instead of drawing great circles through certain points, we regard those points as merely isolated localities in a belt of considerable width, there is no need of fixing the pole of either the Jurassic or the Miocene period with that amount of nicety with which Professor Haughton has ascertained its position. The belt may indeed be made to contain the very places on which the objection is founded. Still the method proposed is a good one, and I hope that as our knowledge of foreign geology extends it may be still further pursued. There is, however, one farther consideration to be urged, and that is as to the safety of regarding all deposits of one geological period as contemporaneous in time. Although an almost identical flora may be discovered in two widely-separated beds, it appears to me that chronologically they are more probably of different ages than absolutely contemporaneous; and, inasmuch as the duration of the Miocene period must have been enormous, there would be time—if once we assume a wandering of the poles—for such wandering to have been considerable between the beginning and end of the period.

I must not, however, detain you longer upon this phase of geological speculation, but will advert to a subject of more practical interest, the discovery of Palæozoic rocks under London. So long ago as 1856 the Kentish Town boring had shown that immediately below the Gault red and variegated sandstones and clays occurred, which Professor Prestwich regarded as probably of Old Red or Devonian age. The boring of Messrs. Meux & Co. has now shown

that under Tottenham Court Road, at a depth of little more than nine hundred feet from the surface, there are true Devonian beds, with characteristic fossils, and that Mr. Godwin Austen's prophecy of the existence of Palæozoic rocks at an accessible depth under London has proved true. Professor Prestwich, from a consideration of the French and Belgian coal-fields, inclines to the belief that in the district north of London carboniferous strata may be found. Unfortunately the expense of conducting deep borings, even with the admirable appliances of the Diamond Boring Company, is so great that I almost despair of another experimental borehole like that carried out in the Wealden district under the auspices of Mr. Willett, being undertaken.

In the department of theoretical geology I would call your attention to some experiments by M. Daubrée, of which he has given accounts at different times to the French Academy of Sciences. In these experiments he has attempted to reproduce on a small scale various geological phenomena, such as faulting, cleavage, jointing, and the elevation of mountain chains. Although the analogy between work in the laboratory and that on the grand scale of nature may not in all cases be perfect, yet these experiments are in the highest degree instructive, and reflect no little credit on the ingenuity of the distinguished chief of the École des Mines.

With regard to recent progress in palæontology, I must venture to refer you to Professor Alleyne Nicholson's inaugural address lately delivered to the Edinburgh Geological Society, but I cannot pass over in silence the magnificent discoveries in North America, which are principally due to the researches of Professors Marsh, Leidy, and Cope. The *diceratherium*, a rhinoceros with

two horns placed transversely, and the *dinoceras*, somewhat allied to the elephant, but with six horns, arranged in pairs, are as marvellous as some of the beasts seen by Sir John Maundevile on his travels, or heard of by Pliny. But perhaps the most remarkable series of remains ever discovered are those which so completely link the existing horse with the *cohippus* and *orohippus*, and still farther extend the pedigree of the genus *equus*, which had already been some years ago so ably traced by Professor Huxley.

Of these American discoveries, as well as those made in the Tertiary beds of Europe, M. Albert Gaudry has largely availed himself in his recent beautiful volume on the links in the animal world in geological times, a work which will long be a text-book on the inter-relation of different orders, genera, and species. I am tempted to make use of some portions of M. Gaudry's own analysis of the book, which he communicated to the Geological Society of France. Beginning with the marsupials of the close of the Secondary and beginning of the Tertiary period, he shows that they are succeeded by such animals as the *pterodon*, the *hyaenodon*, the *proviverra*, and *arctocyon*, which present a mixture of marsupial and placental characters, and to some extent justify a theory of the transition from one order to the other. He next examines the marine mammalia, and points out that, so far as at present known, they make their appearance later than those of the land, and that the examination of the pelvis of the *halitherium* tends to support the idea of the mammals, such as the sirenians, which at the present day have no hind limbs, are descended from terrestrial quadrupeds, for those limbs in the *halitherium* are much less reduced than in its recent successors, the dugong and manatee. After tracing the numerous links which are to be found

between the extinct and living pachydermata, he proceeds to show that, notwithstanding the great distance between them and the ruminants, transitions may be seen. The earliest ruminants were devoid of horns and antlers, but possessed upper incisors, and by a comparison of the molars of different genera it may readily be conceived how the large bosses of the omnivorous teeth of the pachyderms gradually shaded into the small crescents of the teeth of the ruminants. At the same time the passage from the heavy and complicated extremities of the limbs of the pachyderms to the simpler and lighter feet of the ruminants can be traced. The history of the horse family is also discussed, and the descent of existing proboscideans from the mastodonts is shown to be probable, though the previous forms which the mastodonts and dinotheria are derived are as yet unknown. Nor can the origin of the carnivora as yet be suggested, though passages between the six existing families of the order may be observed. In conclusion M. Gaudry devotes a chapter to the quadrumana, and thinks that palæontological observations tend to diminish the isolation in which these mammals now stand with regard to the other orders.

One of the most important features insisted on by Mons. Gaudry is that to which I have already alluded—the development of the complicated molars of most mammals. His view is that by a comparison with early and with fœtal forms the probability may be shown of these compound teeth being made up of what in earlier forms were simple teeth—or, as he has termed them, denticules—which have coalesced in the same manner as have some other parts of the normal bony skeleton. In the compound teeth the denticules in some cases preserve their original conical form, as in the pig tribe; in others are

elongated transversely, so as by their junction to form ridges, as in the tapirs; while in others, again, they are drawn out into longitudinal crescents, as in the ruminants. Between these forms there are, of course, innumerable transitions. They do not, however, appear to me to affect the importance of Mons. Gaudry's observations, which must be regarded as of the highest value in all attempts to trace the inter-relation of different forms of mammalian life. I must not, however, detain you longer on this subject, as I trust that I have said enough to show the importance and interest of this book.

The discoveries of early forms of birds with teeth do not come within M. Gaudry's province; but Professor Marsh has largely added to our knowledge of these remarkable forms. The Tertiary *Odontopteryx toliapicus* from Sheppy, described by Professor Owen, seems rather to be endowed with bony tooth-like processes in the jaw, than actual teeth, and the head of the *Argillornis* from the same locality is at present unknown. But the *Hesperornis* and *Ichthyornis* from the cretaceous beds of America possess veritable teeth, in the one case set in a long groove in the jaw, and in the other in actual sockets. Such intermediate, or, as Professor Huxley would term them, intercalary forms, tend materially to bridge over the gap which at first sight appears to exist between reptiles and birds, but which to many palæontologists was far from being impassable, long before the discoveries just mentioned. The amphiœlous character of the vertebræ of *ichthyornis* presents another most remarkable peculiarity, which is also of high significance. I hear rumours of the discovery of another *archæopteryx* in the Solenhofen Slates, which is said to present the head in a much more complete condition than that in which it occurs on

the magnificent slab now in the British Museum. As yet, I believe, the jaws have not had the matrix removed from them ; but should they prove to be armed with teeth, it will to me be a cause of satisfaction rather than surprise, as confirming an opinion which some fifteen years ago⁹ I ventured to express, that this remarkable creature may have been endowed with teeth, either in lieu of or combined with a beak.

I must not, however, detain you longer with any of these general remarks, which are, moreover, becoming somewhat egotistic, but will now proceed to the business of this Section, in which I hope that more than one paper of great value and interest will be forthcoming.

⁹ Nat. Hist. Rev., vol. v. p. 421.



